New records of the parasitic wasp *Dinocampus coccinellae* (Hymenoptera: Braconidae) and its hosts in South Africa

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Dinocampus coccinellae Schrank (Hymenoptera: Braconidae) is a solitary endoparasitoid of ladybird beetle species (Coccinellidae) from the subfamily Coccinellinae (Obrycki 1989; Majerus 1997). The wasp has a cosmopolitan distribution, encompassing all continents except for Antarctica, and mostly occupying the Holarctic temperate areas with the exception of several southern hemisphere countries (Ceryngier *et al.* 2012). It is known to parasitize at least 55 host species, mainly from Eurasia, Great Britain and North America (Majerus 1997; Yu *et al.* 2011).

Dinocampus coccinellae is a multivoltine species over most of its range and displays thelytokous parthenogenesis, producing mostly females (Majerus 1997; Davis *et al.* 2006). Its life history is fairly well documented (*e.g.* Majerus 1991, 1997; Ceryngier *et al.* 2012). Briefly, wasps use olfactory and visual cues to first locate a coccinellid host (mostly adults), then insert the ovipositor into the host and lay a single egg (Orr *et al.* 1992; Al Abassi *et al.* 2001; Davis *et al.* 2006; Saito & Bjørnson 2013). A single larva will develop inside the host even if the latter has been parasitized multiple times (Ceryngier *et al.* 2012). The larva feeds on trophic cells (teratocytes), the host's body fat and gonads (Kadono-Okuda *et al.* 1995; Geoghegan *et al.* 2000; Firlej *et al.* 2007) and takes ~20 days (at 25 °C) to develop through three instars within the host's abdomen (Obrycki 1989; Maure *et al.* 2011; Ceryngier *et al.* 2012). The fully-developed final instar exits from the host and spins a cocoon between the host's legs (Davis *et al.* 2006; Maure *et al.* 2011). The ladybird then grasps the cocoon and remains partially paralysed throughout the parasitoid's pupation period (Maure *et al.* 2011). The manipulation of the host, acting as a cocoon bodyguard, likely results from the secretion of chemical substances by the larva which affects the host's neurochemistry. The wasp can incur both benefits *via* decreased predation and costs as the host manipulation behaviour lowers fecundity, at least in the short-term (Maure *et al.* 2011). The cocoon remains attached to the ladybird until the wasp emerges, and most hosts die thereafter (Maure *et al.* 2011).

Here, we report new distributional data for *D. coccinellae* (Fig. 1; voucher specimens SAM-HYM-P046381 and SAM-HYM-P046382 deposited in the Iziko South African Museum, Cape Town) originating from individuals that emerged from field-collected ladybird beetles in Stellenbosch, Western Cape Province, South Africa (33°49.634'S 18°47.711'E). Three species native to South Africa (*Cheilomenes lunata* Fabricius, *Adalia flavomaculata* DeGeer and *Exochomus flavipes* Thunberg), the alien species (*Hippodamia variegata* Goeze) and the invasive species (*Harmonia axyridis* Pallas) were found to be parasitized by *D. coccinellae*. The three native ladybirds are new reported hosts for *D. coccinellae*, although the parasitoid had previously been reared from these and other ladybird beetle species in South Africa, but not reported in the literature: *E. flavipes* collected from KwaZulu-Natal in 1948 (specimen in Iziko South African Museum (SAMC); SAM-HYM-P005554), *C. lunata* collected from Gauteng in 1962 and the Free State in 1963–1964 (specimens in National Collection of Insects, Pretoria (SANC), Ac.DB 127), *A. flavomaculata* collected from the Free State in 1964–1966 (specimens in SANC, Ac.DB 128) and *H. variegata* from Gauteng in 1986 (specimens in SANC, Ac.Bi 308).

From a total of 545 ladybird beetle specimens collected in Stellenbosch and its surroundings from March to May 2013, *D. coccinellae* showed the highest rate of emergence from *A. flavomaculata* (n = 37 beetles; 11 % parasitoid emergence rate), followed by *H. variegata* (n = 78 beetles; 9 % parasitoid emergence), *C. lunata* (n = 68 beetles; 4 % parasitoid emergence), *E. flavipes* (n = 35 beetles; 3 % parasitoid emergence) and *H. axyridis* (n = 276 beetles; 0.01 % parasitoid emergence).

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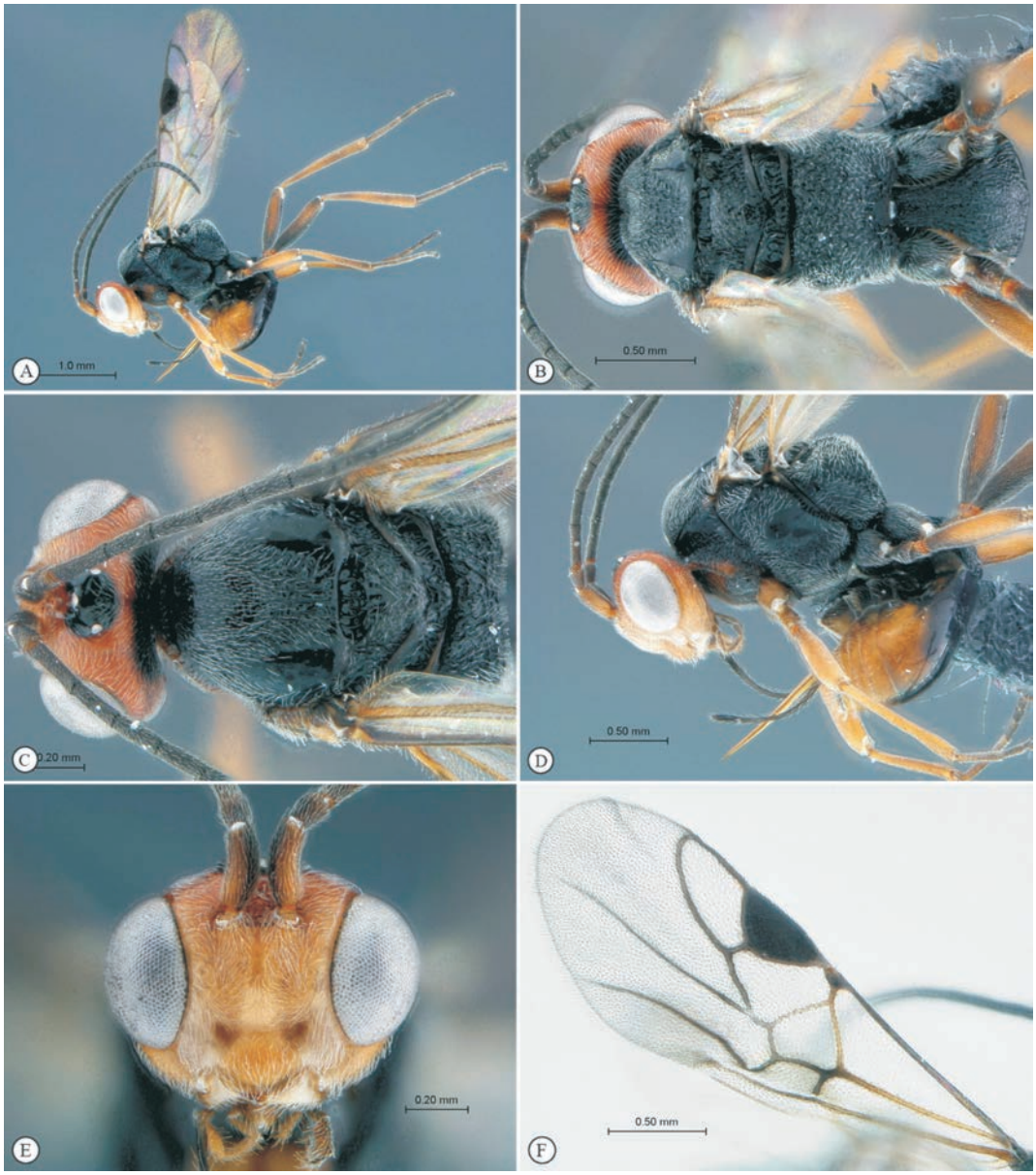

Fig. 1. *Dinocampus coccinellae* female. **A**, habitus lateral view; **B**, head, mesosoma and first tergite postero-dorsal view; **C**, head, mesosoma antero-dorsal view; **D**, head, mesosoma and metasoma lateral view; **E**, head anterior view; **F**, forewing.

Individuals of *Cheilomenes propinqua* (n = 51) were not parasitized or at least not successfully. Parasitized ladybirds of all species showed the characteristic bodyguard behaviour of grasping the parasitoid's cocoon between the legs and remained in this position until wasp emergence (Fig. 2).

The preference in host species by *D. coccinellae* differs across its geographical range (Anderson *et al*. 1986; Majerus 1997), but generally, the parasitoid targets large coccinellid species (Richerson & DeLoach 1972; Ceryngier *et al.* 2012) and favours adult females (Geoghegan *et al.* 1998; Majerus *et al.* 2000; Davis *et al*. 2006). Although the

Fig. 2. *Adalia flavomaculata* displaying typical cocoon bodyguard behaviour during *Dinocampus coccinellae* pupation.

predominant host species vary across regions, the successful parasitization (*i.e.* resulting in wasp development and emergence) of invasive hosts is generally lower than that of native species (Obrycki 1989; Hoogendoorn & Heimpel 2002; Koyama & Majerus 2008; Firlej *et al.* 2010). In particular, a much lower parasite success rate has been found in the invasive *Harmonia axyridis* compared to native species (Koyama & Majerus 2008; Firlej *et al.* 2010) and this finding is in accordance with our preliminary data for *H. axyridis* collected in Stellenbosch. Invasive species may inhibit successful parasitization through increased defensive behaviour against the attacking wasp and/or have a greater immune response against the developing parasitoid larva compared to native species (Berkvens *et al.* 2010; Firlej *et al.* 2010, 2012).

In South Africa, native coccinellids are likely to be negatively impacted by the establishment and spread of alien invasive ladybirds. *Harmonia axyridis* is a highly aggressive species, competing readily with other indigenous ladybird species for resources, and known to have detrimental effects on native ladybird communities (Koch 2003; Pell *et al.* 2008; Roy *et al.* 2012). Although the first formal detection of *H. axyridis* only occurred ~10 years ago, the species has already spread widely in South Africa (Stals & Prinsloo 2007; Stals 2010). The occurrence of *D. coccinellae* in South Africa offers an opportunity to explore interactions between the parasitoid and native and invasive coccinellids. The reporting of these new parasitoid records underlines the need for further examination of the dynamics of ladybird communities in the region, including parasitoid-host interactions, in order to predict likely impacts of invasive ladybird species on native ladybirds and prey communities.

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